OPERATING INSTRUCTIONS

FOR THE

TYPE 207-A UNIVERTER

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY
U. S. A.

Printed in U.S.A.

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TYPE 207-A UNIVERTER

I. INTRODUCTION.

The Type 207-A Univerter, a frequency converting accessory of unity gain, is designed for use with the Types 202-B and 202-C FM-AM Signal Generators to provide additional frequency coverage of 0.1 mc. to 55 mc. Since the 202-B and 202-C FM-AM Signal Generators cover a frequency range from 54 to 216 megacycles, the 207-A offers a simple and convenient means whereby the additional coverage of commonly used intermediate and radio frequencies may be obtained. This instrument also makes available at these lower frequencies the frequency and amplitude modulation features and the attenuator calibration of the 202 instruments, without adding any appreciable distortion.

Physically, the Univerter consists of a front panel assembly, RF chassis, and regulated power supply. The power supply chassis is secured to the rear panel of the equipment cabinet, while connections to the RF

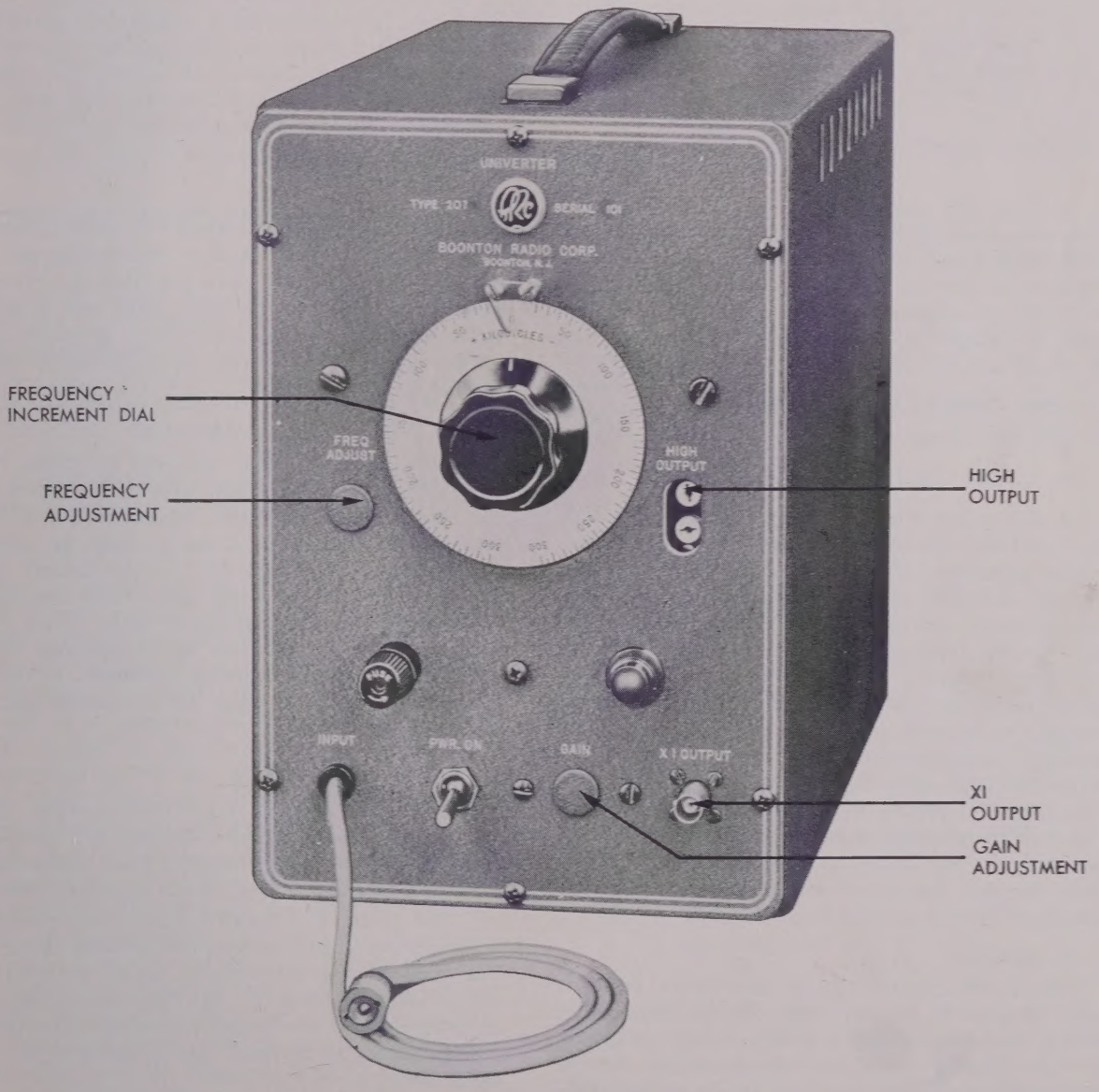


Fig. 1. Front View of 207-A Univerter

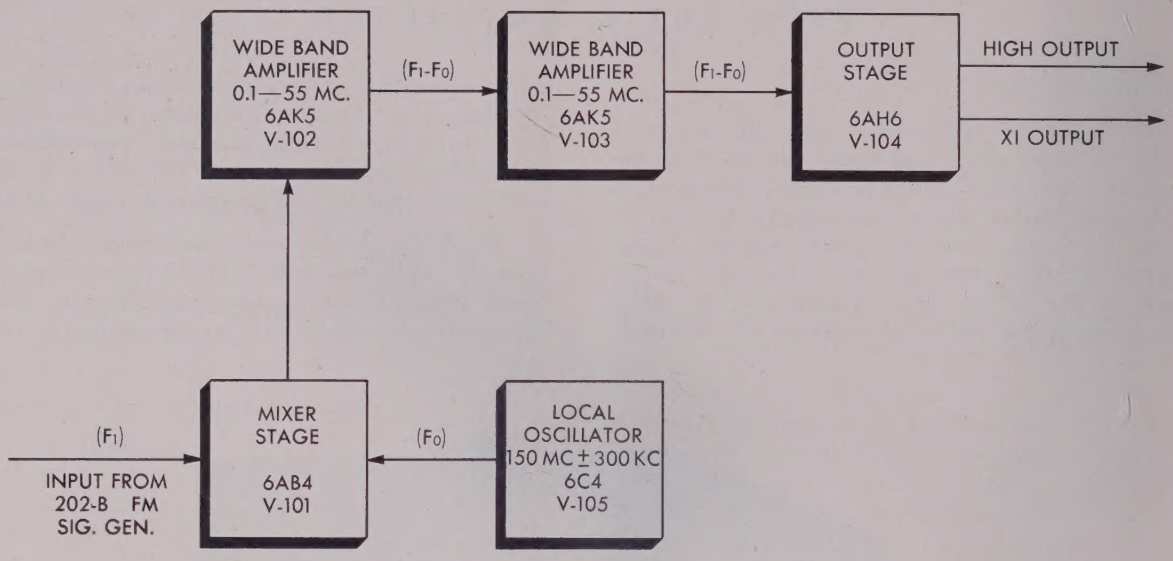


Fig. 2. Basic Elements of 207-A Univerter

chassis are made with a cable and plug arrangement on the front panel. The entire assembly is both lightweight and compact, matching the type 202-B and 202-C FM-AM Signal Generators in proportions and finish. A collapsible leather handle is attached to the top of the cabinet for convenience in carrying.

II. BASIC OPERATING PRINCIPLES.

(See Figs. 2 and 11)

A. LOCAL OSCILLATOR.

A 6C4 triode V105 functions as a modified Colpitts oscillator operating at a frequency of 150 mc. Vernier capacitor C134 permits the 150 mc center frequency to be shifted up or down the frequency spectrum a maximum of 300 kc. The "Frequency Increment Dial" on the front panel of the instrument controls this vernier capacitor and is calibrated in 5 kc. increments, permitting relatively small changes in output frequency to be made such as are required for receiver selectivity measurements. Variable capacitor C137 available through access hole marked "FREQ", provides a means of zero beating the oscillator with the 150 mc output of the 202 generator with which the 207 is associated. A high degree of oscillator stability is obtained through the use of temperature compensating capacitors.

B. MIXER.

The 6AB4 triode V101 as used is an excellent mixer, because of its very high g_m and because its physical characteristics suit it ideally to high frequency use. The pick up coil L110 introduces the 150 mc local oscillator signal to the grid of the 6AB4 triode V101 while the signal from the associated 202 develops a voltage across the cathode resistor R-101. V101 mixes the two signals to produce a difference frequency. The 68-ohm cathode resistor shunted by the tube internal impedance of V101 provides the proper 53 ohm termination for the input cable and a 53 ohm termination for the associated 202 generator whose attenuator dial will therefore read directly the voltage applied to the Univerter.

C. WIDE BAND AMPLIFIER.

The two wide-band cascaded amplifier stages V102 and V103 employ four-terminal, low pass, dead-end filter coupling networks, which pass 0.1 to 55 mc. Gain of the instrument is set to unity by means of potentiometers R128 and R117 in the cathode circuits of the 6AK5 tubes V102 and V103 respectively. Cathode degeneration minimizes Miller effect so that the pass band characteristics are independent of gain control settings. The trimmer condensers in the filter networks are used to adjust for a uniform gain over the entire pass-band.

D. OUTPUT STAGE.

The 6AH6 output stage V104 is both cathode and plate loaded. The plate loading has virtually no effect upon the cathode output circuit indicating that the 6AH6 operates as very nearly a perfect pentode.

The value of resistance chosen for the cathode resistor is such that the output impedance is 53 ohms. The gain of the Univerter is set so that the open circuit voltage across the 53 ohm internal impedance is twice the input voltage. It follows then that the voltage across an external load is obtained by use of ohms law:

$$1.\ Eo = 2E\frac{Z_L}{Z_I + Z_L}$$

Where E_O = 207 output voltage
Where E = 202 attenuator dial reading
Where Z_L = load impedance
Where Z_I = internal impedance

When the external load is 53 ohms the effective gain of the instrument is unity and the attenuator dial of an associated 202 reads the Univerter output directly.

The plate output offers an open circuit gain of 7.5-8 times the input voltage at an internal impedance of approximately 330 ohms. This circuit is factory adjusted for maximum pass band flatness with 10 $\mu\mu$f connected externally to simulate an average external load, which is approximately equivalent to a short length of 300 ohm twin lead plus the input capacitance of a vacuum tube. Although the bandpass as viewed across the cathode is independent of plate load the reverse is not true due to changed degeneration resulting from change in cathode load. Therefore a 501-A cable or equivalent 53 ohm termination must be connected as a cathode load if optimum flatness is desired at the high impedance plate output.

III. OPERATING INSTRUCTIONS.

A. SETUP.

Set up the 207-A Univerter for use as follows: Connect the 501-A output cable (or suitable cable-adapter combination) to the X1 OUTPUT of the Univerter, plug the input coaxial cable of the 207-A into the RF output receptacle of the 202, energize both instruments from any convenient 105-125 volt, 60 cycle power line and allow one hour warm up period before proceeding. (The 207 alone may operate from a 90-130 V, 60 cycle power line.)

B. CHECKS.

The frequency of the Univerter oscillator is checked by zero-beating with a 202 generator. This inspection should be made upon receipt of initial delivery and occasionally thereafter. To perform the check connect a null indicator such as a pair of earphones or a sensitive vacuum tube voltmeter to the high output of the Univerter and set the 202 frequency dial to 150 mc. Remove the plug button marked "FREQ" from the 207 front panel, and adjust variable capacitor C137 for zero beat.

The gain of the Univerter may be measured by comparing its output voltage as read on a vacuum tube voltmeter with the input voltage from the 202, indicated by the attenuator dial. Connect an accurate vacuum tube voltmeter to the X1 OUTPUT with a 501-A cable and shift the 207 oscillator frequency about 100 KC from zero-beat by means of the "Frequency Increment Dial". The reading of the vacuum tube voltmeter and the attenuator may be made equal (unity gain) by adjusting the first amplifier cathode potentiometer R128 (Fig. 4), accessible by removing the plug button marked "GAIN" from the front panel.

C. OPERATING PROCEDURE.

1. *The lower frequency limit* is determined in part by the service desired since the fundamental frequency must be sufficiently removed from the lower pass band limit to avoid side band cutting as follows:

Service	Lower Frequency Limit
CW	100 kc
AM-Modulation —	100 kc + Modulation Frequency
FM-Modulation —	100 kc + Deviation Frequency + Modulation Frequency*

2. *The Frequency Increment Dial* is useful in providing small frequency changes, in increments of 5 KC to a total of +300 KC. This feature is convenient when measuring pass band characteristics of amplifying systems. Where the greatest degree of accuracy is desired, the frequencies involved should be approached with the same direction of rotation to minimize the effects of backlash.

3. *The method of connecting the load* to the Univerter must be considered to insure proper interpretation of results, and the following discussion is offered as an aid to the user:

It is convenient to represent a signal source in terms of its open circuit voltage and internal impedance.* Thus a signal source or an antenna can be represented as in Figure 3. For simplicity, only the case where source and load impedance are resistive will be considered.

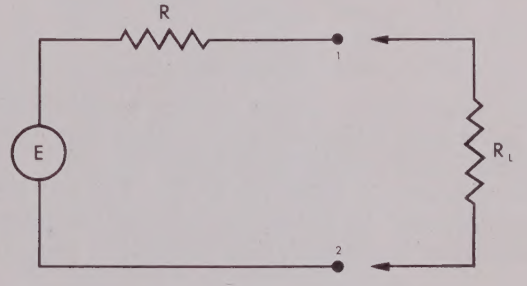


Fig. 3. Signal Source Representation

E — open circuit voltage
R — impedance looking into terminals 1 and 2
R_L — load impedance

For purposes of rating sensitivity, the input to a receiver might have been defined initially either as the open circuit source voltage E or the voltage actually across the receiver's terminals. The Institute of Radio Engineers has established the former method

*Radio Engineering, F.E. Terman, Third Edition, Page 486.
*General Radio Experimenter, Vol. XXI, No. 1, June, 1946.

as standard and defined receiver input in terms of the open circuit voltage of the source.**

The impedance of the signal source employed to test receivers should be equal to the impedance of the antenna with which the receiver is designed to operate. Note that in this case the voltage actually across the receiver terminal is $\frac{E}{2}$ (Receiver input impedance equal to source impedance.)

4. *Accessories* for physically connecting the instrument to the load are described in the following:

a. 505-A, 6db Pad

This pad is used as a dummy antenna in testing unbalanced receivers with a 53-ohm input as shown in Figure 4.

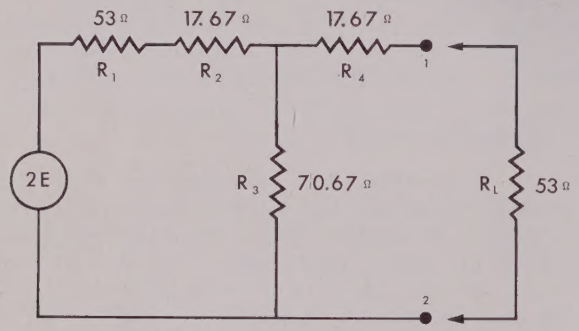


Fig. 4. 505-A T-Pad as Dummy Antenna for Receiver

E — 202 attenuator dial reading
R_1 — internal resistance of Univerter
R_2 — pad resistance
R_3 — pad resistance
R_4 — pad resistance
R_L — load impedance

The open circuit voltage appearing across terminals 1 and 2 is by Ohms law (equation 1) equal to E, half of the source voltage. Applying Thevinin's theorem the equivalent circuit of Figure 5 is obtained, and thus the attenuator dial of the 202 reads receiver sensitivity directly for the assumed standard output.

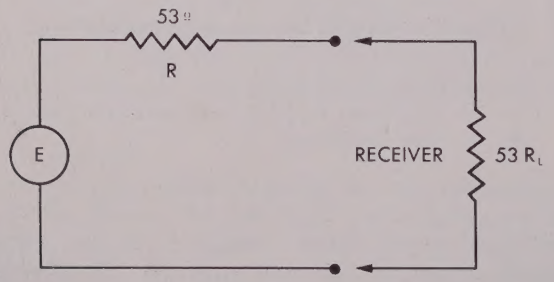


Fig. 5. Equivalent Circuit of a 505-A T-Pad as an Antenna

b. 509-A 20 db T-Pad

This pad is useful where signal levels are required which are low compared to the constant noise level of the 207. Since the noise level of the 207 is constant, the signal to noise ratio varies directly as the signal level. Therefore, with low output voltage the signal to noise ratio may be improved by increasing the input voltage and attenuating the output. For practical purposes the 20 db pad is useful at output levels below 5,000 microvolts for the 202-C and 500 microvolts for the 202-B. The signal applied to a 53-ohm load may be found by dividing the 202 attenuator dial reading by ten.

The 509-A pad, like the 505-A, may be used as a dummy antenna except that the measure of receiver sensitivity (equivalent source voltage) is one-fifth the 202 attenuator dial reading.

c. 501-A Output Cable

A 501-A Cable attached to the Univerter is illustrated by Figure 6a, where R_2 is the 53 ohm termination of the 501-A cable. The equivalent circuit (Figure 6b) is readily determined by applying Thevinin's theorem. This arrangement is recommended for general use where it is desirable to connect the Univerter output to an input circuit of relatively higher impedance than 26 ohms. The attenuator of the 202 will read the Univerter output directly.

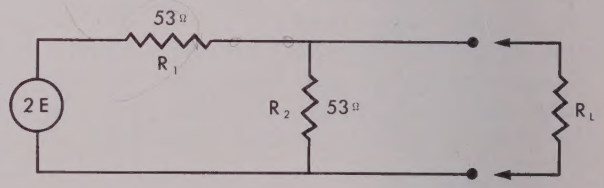


Fig. 6a. Output Circuit of 207-A with 501-A Output Cable Attached

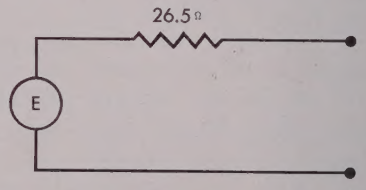


Fig. 6b. Equivalent Output Circuit of 207-A with 501A Output Cable Attached

E — 202 attenuator dial reading
R_1 — 207 internal resistance
R_2 — 501-A cable termination
R_L — load impedance

**The Institute of Radio Engineers, Section 4.01.01, 1947, Standards on Radio Receivers, The Institute of Radio Engineers, Section 4.01.01, 1948, Standards on Television.*

IV. SPECIFICATIONS.

A. RF RANGE.

Over a range of 0.1 mc. to 55 mc., with no carrier deviation, the gain of the Univerter when used in combination with the 202-B or 202-C Signal Generator is constant at unity to within ±1 db.

B. FREQUENCY INCREMENT DIAL.

This dial is calibrated in 5-kc divisions over a range of ±300 kc.

C. RF OUTPUT.

The RF output voltage across a 53 ohm load connected to the X1 OUTPUT jack is continuously variable from 0.1 microvolt to 0.1 volt by means of the 202-B or -C FM Signal Generator attenuator. At 0.2 volt input, the output is approximately 0.18 volt.

The impedance at the X1 OUTPUT jack, looking into the instrument terminal is approximately 53 ohms.

The RF output voltage at the HIGH OUTPUT jack is uncalibrated but may be controlled from the attenuator of the 202 FM-AM Signal Generator to give a maximum of about 1.5 volts. At this jack the internal impedance is approximately 330 ohms.

D. DISTORTION.

1. FM. The Univerter introduces no appreciable distortion when a frequency modulated voltage is applied from the 202-B Signal Generator.

2. AM. At carrier levels below 0.05 volts the Univerter adds no distortion to a 50% AM modulated signal. Above this level some rounding of the outward modulation peaks may occur.

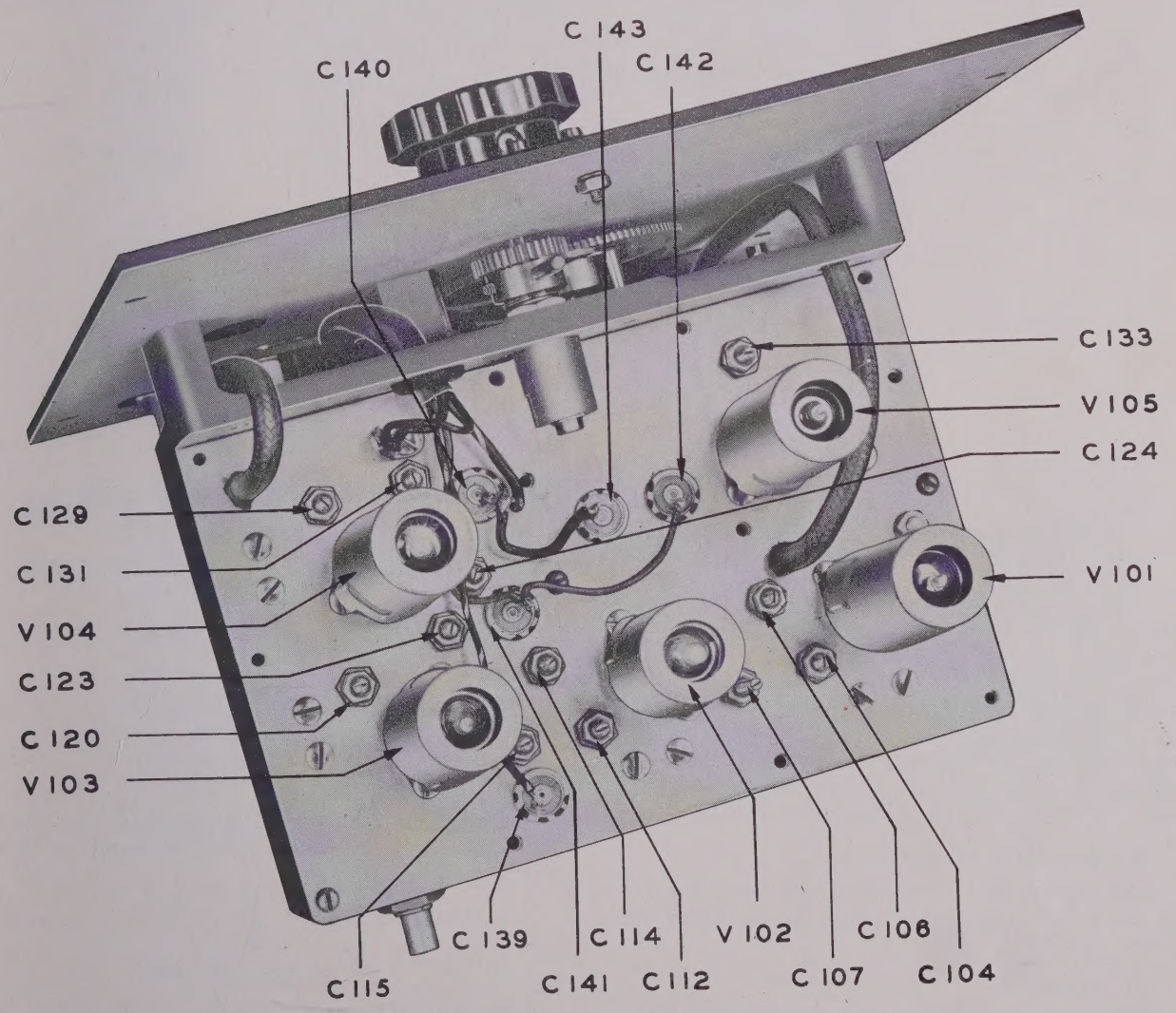


Fig. 7. Top View of 207-A Panel and RF Chassis

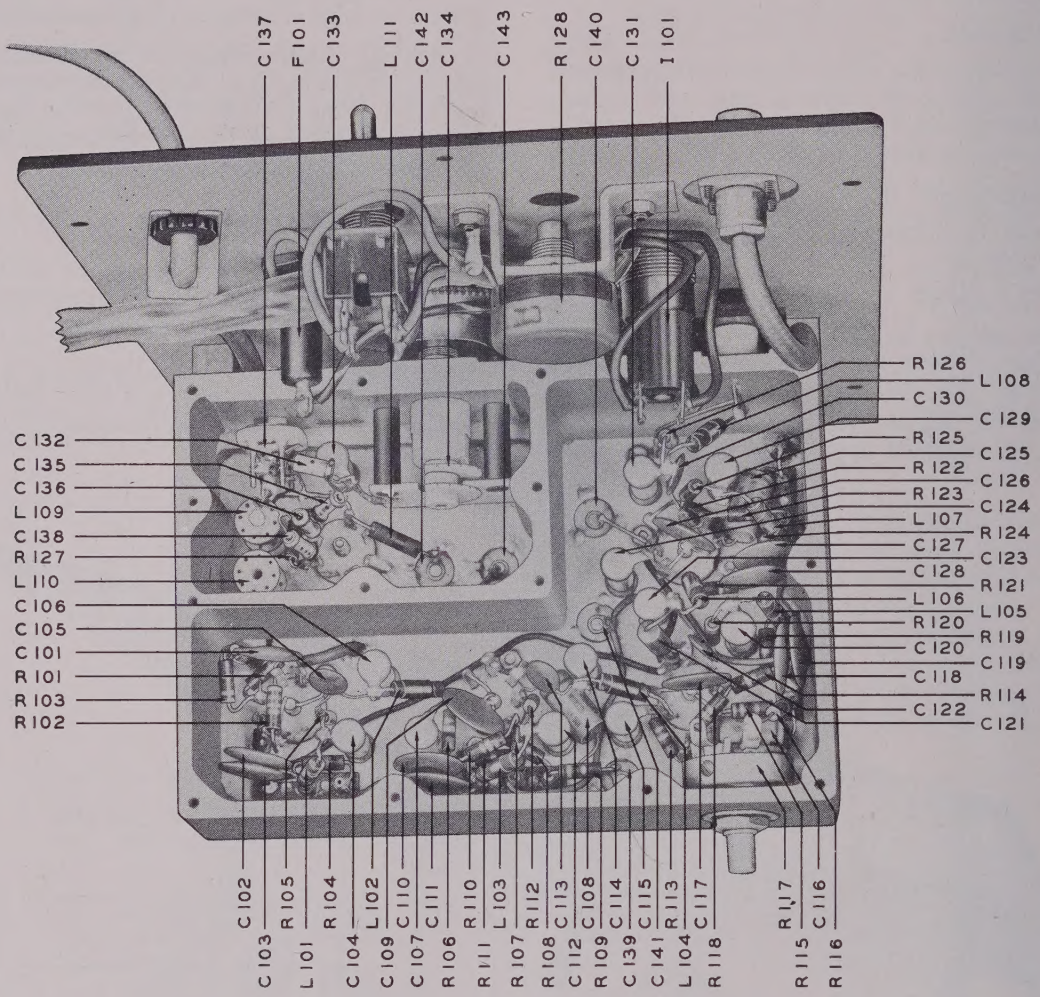


Fig. 8. Bottom View of 207-A Panel and Open RF Chassis

E. LEAKAGE.

The RF unit is completely shielded, being enclosed within an aluminum casting having silver plated brass cover plates screwed firmly in place. The oscillator section is well shielded from the remainder of the RF unit by aluminum walls within the main casting. This use of shielding reduces leakage to a low value. Leakage of the fundamental frequency is a maximum at 55 mc and occurs at the HIGH OUTPUT plug. This leakage is 50 db below the desired signal.

F. SPURIOUS RF OUTPUT.

All spurious RF output voltages at input levels of less than 0.05 volts are at least 30 db below the desired signal.

G. NOISE.

FM hum modulation is more than 80 db below 10 kc deviation.

Random noise is 4 μv over a 20 kc band width.

H. TUBE COMPLEMENT.

Oscillator - 6C4 (V-105)
Mixer - 6AB4 (V-101)
RF Amplifier - 6AK5 (V-102, V-103)
Output Stage - 6AH6 (V-104)

I. POWER SUPPLY.

The 207-A Univerter is designed for use on 60 cycles, 90-130 volts, with a power consumption of 45 watts.

J. DIMENSIONS.

H: 11½" W: 7⅜" D: 10½"

K. WEIGHT.

20 pounds.

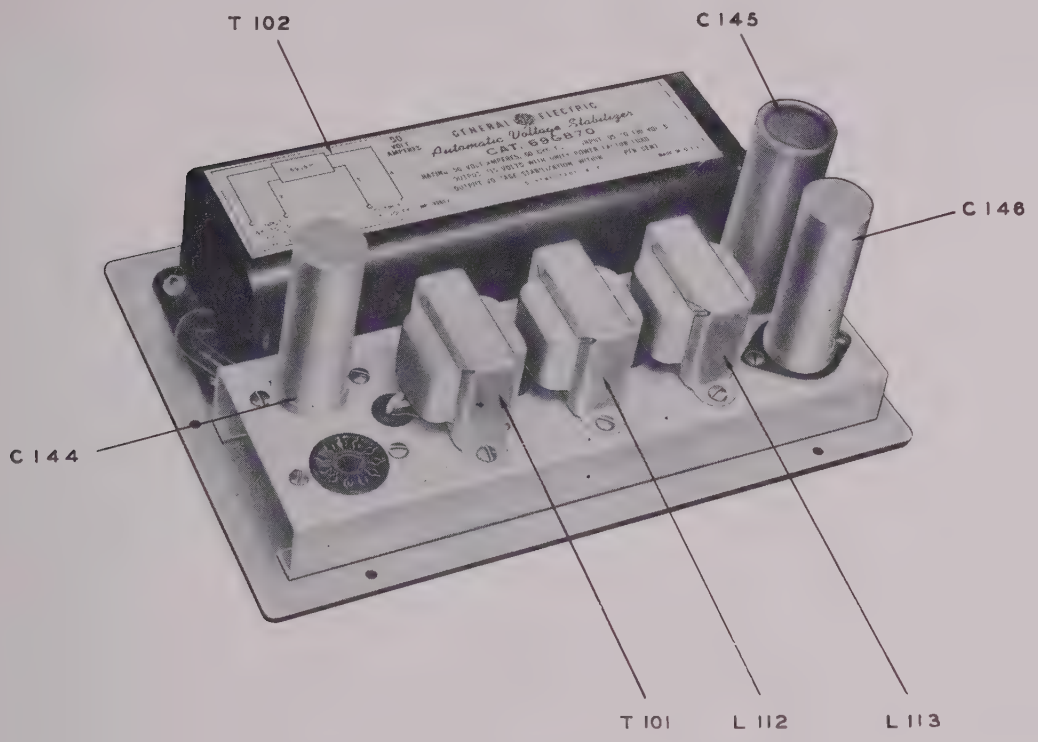


Fig. 9. Top View of 207-A Power Supply

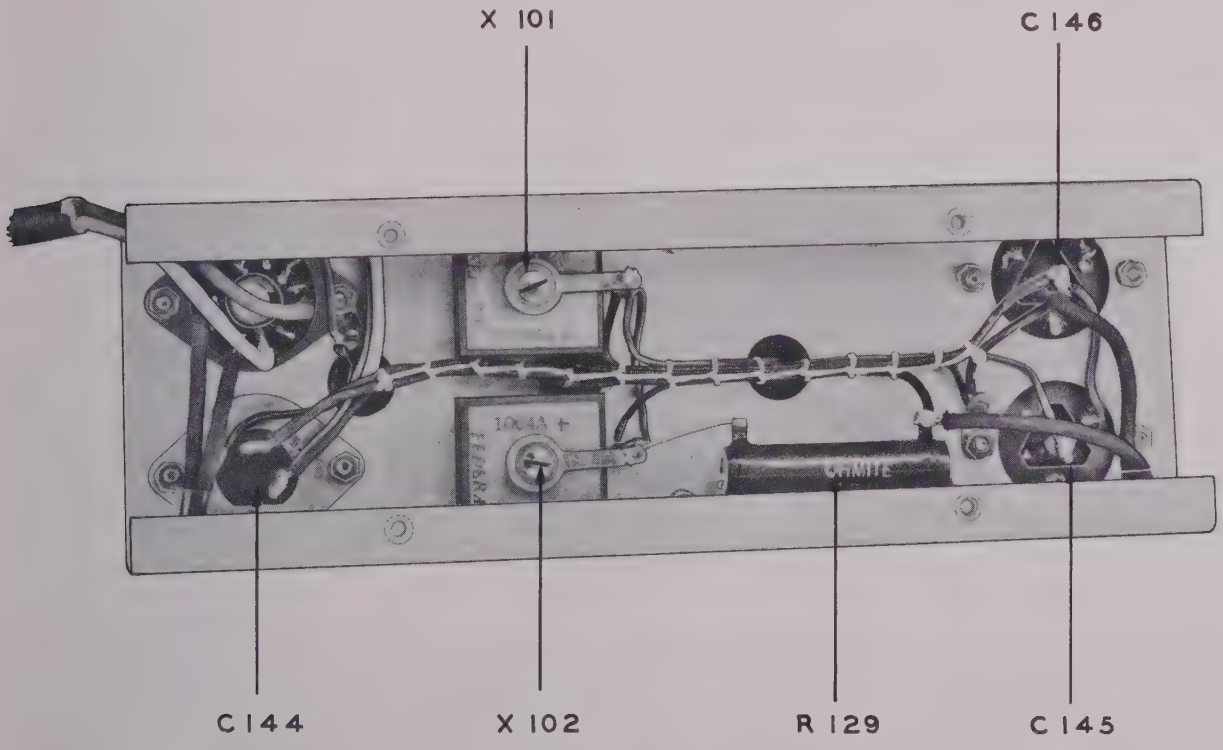


Fig. 10. Bottom View of 207-A Supply

TYPE 207-A UNIVERTER
ELECTRICAL COMPONENTS PARTS LISTS

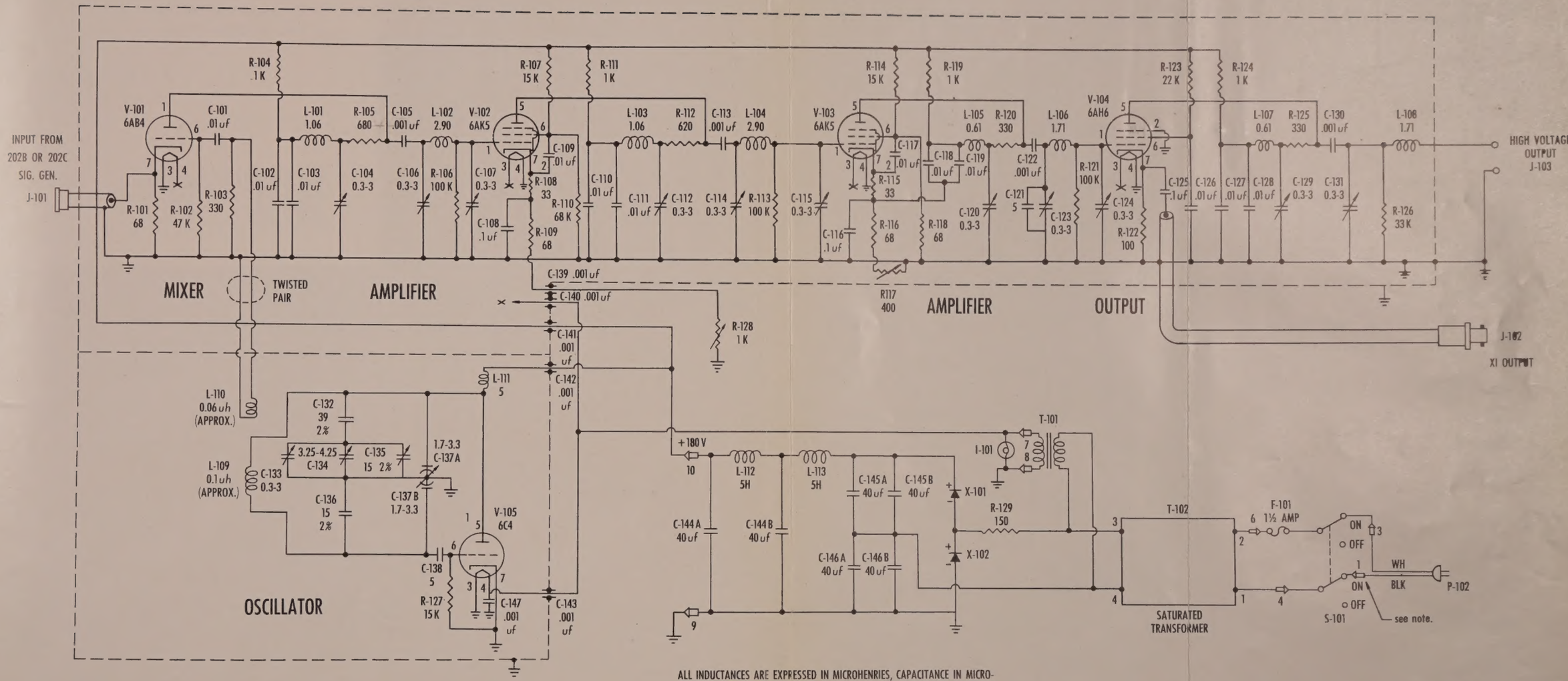
Circuit Symbol	Value	Description	BRC Part No.
R-101	68 ohms	Resistor Fixed, ½ watt ±5%	80057
R-102	47K ohms	Resistor Fixed, ½ watt ±5%	80460
R-103	330 ohms	Resistor Fixed, ½ watt ±5%	80172
R-104	1K ohms	Resistor Fixed, ½ watt ±5%	80148
R-105	680 ohms	Resistor Fixed, ½ watt ±5%	80138
R-106	100K ohms	Resistor Fixed, ½ watt ±5%	80517
R-107	15K ohms	Resistor Fixed, ½ watt ±5%	80336
R-108	33 ohms	Resistor Fixed, ½ watt ±5%	80032
R-109	68 ohms	Resistor Fixed, ½ watt ±5%	80057
R-110	68K ohms	Resistor Fixed, ½ watt ±5%	80549
R-111	1K ohms	Resistor Fixed, ½ watt ±5%	80148
R-112	620 ohms	Resistor Fixed, ½ watt ±5%	80191
R-113	100K ohms	Resistor Fixed, ½ watt ±5%	80517
R-114	15K ohms	Resistor Fixed, ½ watt ±5%	80336
R-115	33 ohms	Resistor Fixed, ½ watt ±5%	80032
R-116	68 ohms	Resistor Fixed, ½ watt ±5%	80057
R-117	400 ohms	Resistor Variable, 2 watt potentiometer	81116
R-118	68K ohms	Resistor Fixed, ½ watt ±5%	80549
R-119	1K ohms	Resistor Fixed, ½ watt ±5%	80148
R-120	330 ohms	Resistor Fixed, ½ watt ±5%	80172
R-121	100K ohms	Resistor Fixed, ½ watt ±5%	80517
R-122	100 ohms	Resistor Fixed, ½ watt ±5%	80062
R-123	22K ohms	Resistor Fixed, ½ watt ±5%	80472
R-124	1K ohms	Resistor Fixed, ½ watt ±5%	80148
R-125	330 ohms	Resistor Fixed, ½ watt ±5%	80172
R-126	33K ohms	Resistor Fixed, ½ watt ±5%	80461
R-127	15K ohms	Resistor Fixed, ½ watt ±5%	80336
R-128	1K ohms	Resistor Variable, 2 watt potentiometer	81119
R-129	150 ohms	Resistor Fixed, 20 watt ±5%	80090
C-101	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-102	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-103	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-104	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-105	1000 μμf	Capacitor, Fixed +80% —20% 600V	82306
C-106	.3-3 μμf	Capacitor, Variable pyrex tubular	84000

TYPE 207-A UNIVERTER ELECTRICAL COMPONENT PARTS LIST - *Continued*

Circuit Symbol	Value	Description	BRC Part No.
C-107	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-108	.1 μf	Capacitor, Fixed +30% —20% 200V	83019
C-109	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-110	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-111	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-112	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-113	1000 μμf	Capacitor, Fixed +80% —20% 600V	82306
C-114	.3-3μμf	Capacitor, Variable pyrex tubular	84000
C-115	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-116	.1 μf	Capacitor, Fixed +30% —20% 200V	83019
C-117	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-118	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-119	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-120	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-121	5 μμf	Capacitor, Fixed ±5% ceramic	82032
C-122	1000 μμf	Capacitor, Fixed +80% —20% 600V	82306
C-123	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-124	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-125	.1 μf	Capacitor, Fixed +30% —20% 200V	83019
C-126	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-127	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-128	.01 μf	Capacitor, Fixed +80% —20% 600V	82428
C-129	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-130	1000 μμf	Capacitor, Fixed +80% —20% 600V	82306
C-131	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-132	39 μμf	Capacitor, Fixed ±2%	82018
C-133	.3-3 μμf	Capacitor, Variable pyrex tubular	84000
C-134	3.25-4.25 μμf	Capacitor, Variable frequency increment	
C-135	15 μμf	Capacitor, Fixed ±2% N150 500V ceramic	82013
C-136	15 μμf	Capacitor, Fixed ±2% NPO 500V ceramic	82023
C-137	A1.7-3.3 μμf B1.7-3.3 μμf	Capacitor, Variable (butterfly)	84011
C-138	5 μμf	Capacitor, Fixed ±5% NPO 500V ceramic	82003
C-139	.001 μf	Capacitor Fixed Button type ±10%	82307
C-140	.001 μf	Capacitor Fixed Button type ±10%	82307
C-141	.001 μf	Capacitor Fixed Button type ±10%	82307

TYPE 207-A UNIVERTER ELECTRICAL COMPONENT PARTS LIST - *Continued*

Circuit Symbol	Value	Description	BRC Part No.
C-142	.001 μf	Capacitor Fixed Button type ±10%	82307
C-143	.001 μf	Capacitor Fixed Button type ±10%	82307
C-144	A 40 μf B 40 μf	Capacitor Fixed electrolytic 200V	83094
C-145	A 40 μf B 40 μf	Capacitor Fixed electrolytic 200V	83093
C-146	A 40 μf B 40 μf	Capacitor Fixed electrolytic 200V	83094
C-147	.001 μf	Capacitor Fixed Button type ±10%	82307
L-101	1.06 μh	Choke, ±3%	300326
L-102	2.90 μh	Choke, ±3%	300325
L-103	.06 μh	Choke, ±3%	300326
L-104	2.90 μh	Choke, ±3%	300325
L-105	0.61 μh	Choke, ±3%	300323
L-106	1.71 μh	Choke, ±3%	300322
L-107	0.61 μh	Choke, ±3%	300323
L-108	1.71 μh	Choke, ±3%	300322
L-109	0.1 μh approx.	Oscillator coil assembly	300328
L-110	0.06 μh approx.	Pick-up coil assembly	300329
L-111	5 μh	Choke, ±5%	300327
L-112	5 h	Choke	85412
L-113	5 h	Choke	85412
T-101		Transformer, filament	85003
T-102		Constant voltage stabilizer	85028
I-101	6.3 v, 0.15a	Lamp, incandescent	90904
V-101		6AB4	
V-102		6AK5	
V-103		6AK5	
V-104		6AH6	
V-105		6C4	
X-101	100 ma	Rectifier, selenium	300316
X-102	100 ma	Rectifier, selenium	300316
F-101	1½A	Fuse	93250



ALL INDUCTANCES ARE EXPRESSED IN MICROHENRIES, CAPACITANCE IN MICRO-MICROFARADS, AND RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED.

"K"=1,000; "M"=1,000,000

➔ POWER SUPPLY CHASSIS PLUG P-101
POINT OF SYMBOL INDICATES DIRECTION OF WIRE COMING FROM PLUG PRONG INTO CABLE.

Fig. 11. Schematic Wiring Diagram of 207-A Univerter

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